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A Research on the Direct Utilization of Standard Vegetable Oils as a Fuel in Diesel Engine*

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Abstract: The factors such as increasing energy demand, energy sustainability in the supply energy safety and protection of environment has accelerated the demand for alternative energy sources. Biodiesel is also an alternative fuel, which is intended to use in diesel engines and whose availability has been proven. However, both regulations and economic sanctions have prevented to achieve desired biodiesel production, utilization and marketing. This negative trend has affected agricultural sector as other sectors and as a consequence, important problems have been encountered in the obtaining of raw materials. In this study funded by a project of TÜBİTAK 108 O 419, fuel properties of safflower oil was investigated and transforming safflower oil to standard fuel and its direct usage in the diesel engine with aid of a designed kit was studied.
As a result, sustainable solution proposals related with direct use of vegetable oils especially in agricultural tractors were developed.
Key words: Vegetable oil, Safflower, Diesel Engine, Kit

INTRODUCTION

Turkey, vegetable oil used as fuel in the first operation in 1934 on "The Use of Vegetable Oil in Agricultural Tractors" made under the name of Atatürk Forest Farm. This work constitutes the main reason of the "assurance of supply of energy" by increasing the validity remains today (Öğüt ve Afacan, 2009).

Toxic leftovers, to review the ozone layer, pollution of land, water, air pollution and soil pollution on the environment such as the terms of the agenda in today's world are created term. Increased environmental awareness of industry and public awareness to environmental scientists is to make the activities. It considers the world and many governments and as related to the use of environmentally friendly products, the law has done. The use of vegetable oils as fuel and lubricants for this application is an example (Oğuz, 2004).

Related to vegetable oils (DIN V 51605) the direct use as a fuel without appropriate standards occurs to cause the problem to the fuel injection pumps, injectors and combustion chamber in engines. Therefore, to reduce viscosity or to make the standards oil is to done investigations (Öğüt et. al, 2006). The following procedures relating to the use of vegetable oils are given Figure 1.

These fuel properties of vegetable oils in the direction of improvement or some changes made in the engine are provided (Brien and Richard, 1998). Over vegetable oils in the chemical process is transesterifikasyon to the most accepted method. Obtained with this method of fuel is called biodiesel. TSE 14214 is to give had to properties. In Turkey in 2006 to 290 units of biodiesel production plant was established. However, it does not pump up sales permits, licenses have to be very difficult to purchase as many factors have led manufacturers to abandon production.

This trend has been the impact on farmers. This study was investigated direct use of vegetable oils in the engine modifications made. Providing to standard features of the vegetable oil used in European Union countries is given to recommendations.

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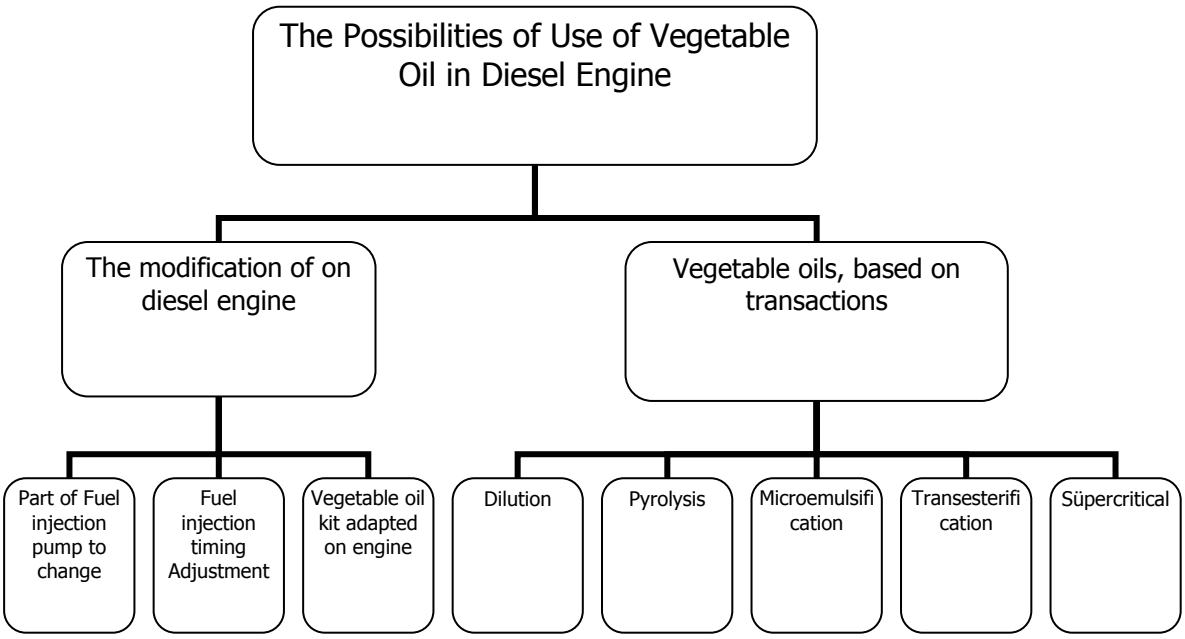

Fig. 1. Being used of vegetable oils methods in diesel engines

Vegetable oils can be used directly as fuel engine without converted for biodiesel. In this case, running the engine with diesel fuel and vegetable oil must be heated. Used as fuel directly of vegetable oil in is not notice of the new oil or waste oil fries (Öğüt ve Oğuz 2006).

However, a heater system (HS) for these applications in the engine requires the use. Engine is firstly run with diesel fuel. Then, viscosity of vegetable oil by using engine cooling water temperature is reduced to the level the viscosity of diesel fuel. However, usage of the engine in terms of the warranty should be good viewing.

Oğuz et al. a variety of vegetable oils by added to diesel engine a kit were tested as fuel.

These oils are investigated of impact on engine performance. Adapted to the engine HS picture is seen in Figure 2.

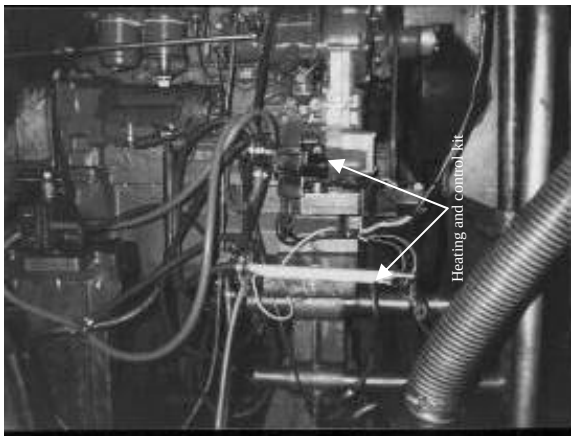

Fig. 2. Test engine and adapted heating and control kit (Oğuz et al. 2004)

STANDARD OF VEGETABLE OIL, CURRENT ACTIVITIES IN GERMANY AND AUSTRIA

A project carried out in Germany and Austria with the standards for the use of rape oil as fuel has been prepared. Tractors companies, farmers, manufacturers of engine kit companies, agriculture ministries and universities in the project has taken place and worked. In different regions of Germany was carried out on about 100 tractors. Standards are given Table 1.

Ammerer et al. double-tank systems to run their engines and tractors were investigating the feasibility. Shape of double-tank kit is seen with use of vegetable oil Fig. 3. One of the vegetable oil to another fuel tank is placed diesel fuel.

The engine works with diesel fuel on the engine cold in dual fuel tanks system. Cooling water temperature reaching 60 °C vegetable oils by changing the magnetic valve position, fuel will be sent to fuel system. Vegetable oil to be sent to fuel system is to works with the electric heater and also, and heating plant oils are sent to the combustion chamber. In addition to the fuel tank with dual fuel equipment, vegetable oil tank, electric fuel pump, oil radiator, the magnetic valve, electric heater is added.

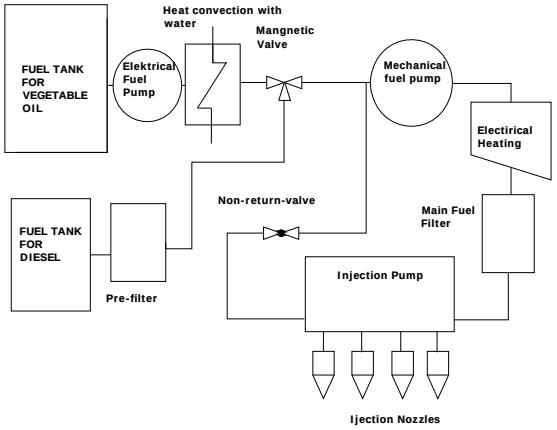

Fig. 3. Shape of double-tank kit with use of vegetable oil (Ammerer et al., 2004)

Table 1. Quality standard for rapeseed oil as a fuel (DIN V 51605)

characteristics/	**units**	**limiting values**		**test procedure**
substances		**min.**	**max.**	
characteristic properties				
density (15º)	kg/m3	900	930	DIN EN ISO 3675 DIN EN ISO 12185
flash point	° C	220		DIN EN ISO 22719
calorific value	kJ/kg	35,000		DIN 51900-3
kinematic viscosity (40 °C)	Mm2/s		38	DIN EN ISO 3104
behaviour at low temperatures				rotation viscosimetry
cetane number				process is being evaluated
coke residues	% by mass		0.40	DIN EN ISO 10370
iodine number	G/100g	100	120	DIN 53241-1
sulphur content	mg/kg		20	ASTM D 5453-93
variable characteristics				
total contamination	mg/kg		25	DIN EN 12662
neutralisation value	Mg KOH/g		2.0	DIN EN ISO 660
oxidation stability	h	5.0		ISO 6886
phosphor content	mg/kg		15	ASTM D3231-99
ash content	% by mass		0.01	DIN EN ISO 6245
water content	% by mass		0.075	pr EN ISO 12937

MATERIAL and METHOD

Material

In this study, the oils of safflower, soybean, mustard and rape seeds obtained from "Research Institutes and Anatolia Agricultural Research Institute, Eskişehir" were extracted and used as experimental material and their properties were investigated. The properties of the extracted oils were investigated using the standards of TS EN 14214, TS EN 14213 and DIN V 51605 and their measurements were conducted in the Biodiesel Analysis Laboratory (funded by the project of DPT 2004/7) in the Agriculture Faculty of Selcuk University. Analysis results were presented in Table 2.

A cooling room was constructed in order to conduct engine experiments under controlled conditions. Hydraulic dynamometer and engine test mechanism were installed in the cooling room, which is illustrated in the Fig. 4.

RESULTS and DISCUSSION

While density of the vegetable oils ranged between 917 and 923 kg/cm^3, density of diesel fuel was 837.2 kg/cm^3. The viscosity values of the vegetable oils at 40 ºC were 15 times higher than that of the diesel fuel. However, the viscosity value could be brought into the suitable condition by increasing the temperature with a kit installed on the engine. Fig. 5 illustrates the alterations in the kinematic viscosity values depending on the temperature of vegetable oils and diesel fuel. The viscosity values of the vegetable oils decreased as the running temperature of engine was approached and their viscosity values approached to that of the diesel fuel. In this respect, this principle was the base component for the modifications performed in engine in order to use the vegetable oils as fuel.

Fig.4. Cooling room and engine test mechanism

Table 2. The properties of safflower, soybean, mustard and rape seed oils and their comparison with standard values

	Raw Safflower Oil (Remzibey-05)	Raw Soybean Oil	Mustard oil	Rape Seed Oil	**DIN V 51605** Min - Max		Biodiesel DIN EN 14214 Min - Max		Diesel Fuel
Oil range (%)	21,98*		26**	23,7*					-
Density at 15 ºC (kg/m^3)	923	928,6	917,4	922,5	900	930	860	900	837,2
Kinematic viscosity (mm^2/s) at 40 ºC	32,15	32,85	44,152	34,73	-	36	3.5	5.0	2,775
at 70 ºC	14,162	14,893	18,298	15,07					1,689
at 100 ºC	7,744	8,047	9,832	8,275					1,181
pH	5,5	6	5,5	5,5	-	-	-	-	-
Copper Strip Corrosion (3 hours at 50 °C)	1a	1a	1a	1a	-	-	-	1	1a
Flash Point (ºC)	100	110	140	120	220	-	120	-	53
Colour	2,0	2,8	2,3	2,1	-	-	-	-	1,7
Water Content (mg/kg)	1249	1205	421,5	1989,6	-	750	-	500	41,137
Iodine value (g iyot/100g)	117,9	102,4	92,5	100,2	95	120	-	120	-
Acid Value (mg KOH/g)			0,16		-	2,0	-	0.5	-
Calorific value (kJ/kg)	40228	40550	41427	40495	36000	-	-	-	45482

*Cold pres ** Screws pres

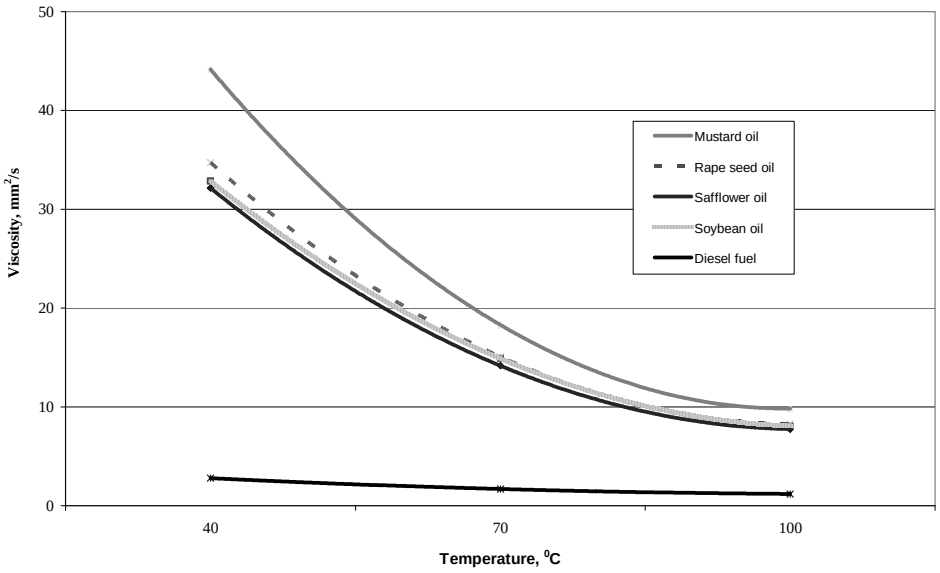

Fig. 5. Variation in the viscosity of the vegetable oils and diesel fuel depending on temperature

The flash points of vegetable oils are higher than 100 ºC, while that of the diesel fuel was 53 º C. Utilization of the vegetable oils are more reliable with respect to their safety and storage. Calorific values of the vegetable oils were approximately 10 % lower than that of the diesel fuel, which could be disadvantage for vegetable oils. However, in the previous studies, it was observed that vegetable oils did not give rise to a power fall, but an increase in the specific fuel consumption.

CONCLUSIONS

The regulations in Turkey prevent the agriculture community to utilize biodiesel, and consequently a desired level in the oil seed production could not be reached. A number of studies have been conducted on the direct usage of vegetable oils in diesel engines as fuel so far; however, desired outcome could not be achieved with respect to their prevalent usage. Instead of direct usage of vegetable oils, their several important properties (water content, acid and iodine number, total contamination, phosphorus, sulfur and oxidation stability) are needed to bring to the desired levels; namely, they need to be processed using some chemical treatments. It is not difficult to achieve these properties.

As a consequence, "In Order For the Vegetable Oil To Be Utilized As a Fuel In Proper Tractors" in agricultural community, "Fuel Aimed Vegetable Oil Standard" should be determined. This regulation could be commonly used both in the cultivation of food qualified oil plants and in the cultivation of non-food qualified oil plants such as mustard and crambe.

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